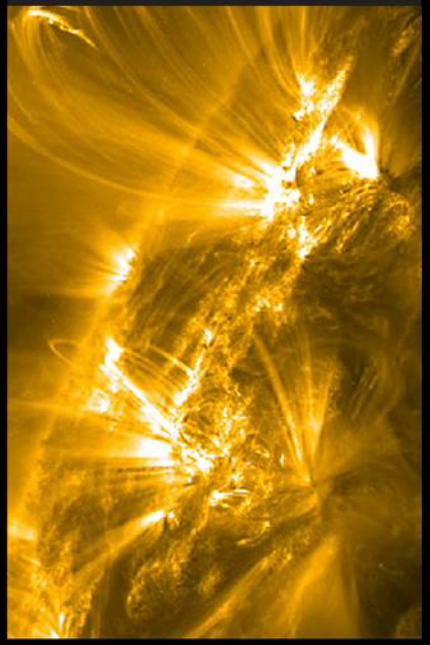
National Aeronautics and Space Administration

EARTH SCIENCE



HELIOPHYSICS

PLANETARY SCIENCE

ASTROPHYSICS

NASA's Science Programs

Presentation to NAC
Dave McComas
July 2012

www.nasa.gov

Science Committee Members

Wes Huntress, Chair
Maura Hagan*, Univ. Corp. for Atmospheric Research; Chair of Heliophysics
Noel Hinners, Independent Consultant
Eugenia Kalnay, Univ. of Maryland
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Meg Urry*, Yale Univ.
Charlie Kennel, Chair of Space Studies Board (*ex officio* member)

T. Jens Feeley, NASA Executive Secretary (Thanks for all the help! - Dave)

* = New Members

Agenda

- **Science Results**
- Programmatic Status
- Findings & Recommendations

Large Extraterrestrial L-Amino Acid Excesses Discovered in the Tagish Lake Meteorite

. . . provide an important clue to how left handed based protein life started on the primitive Earth

water extract

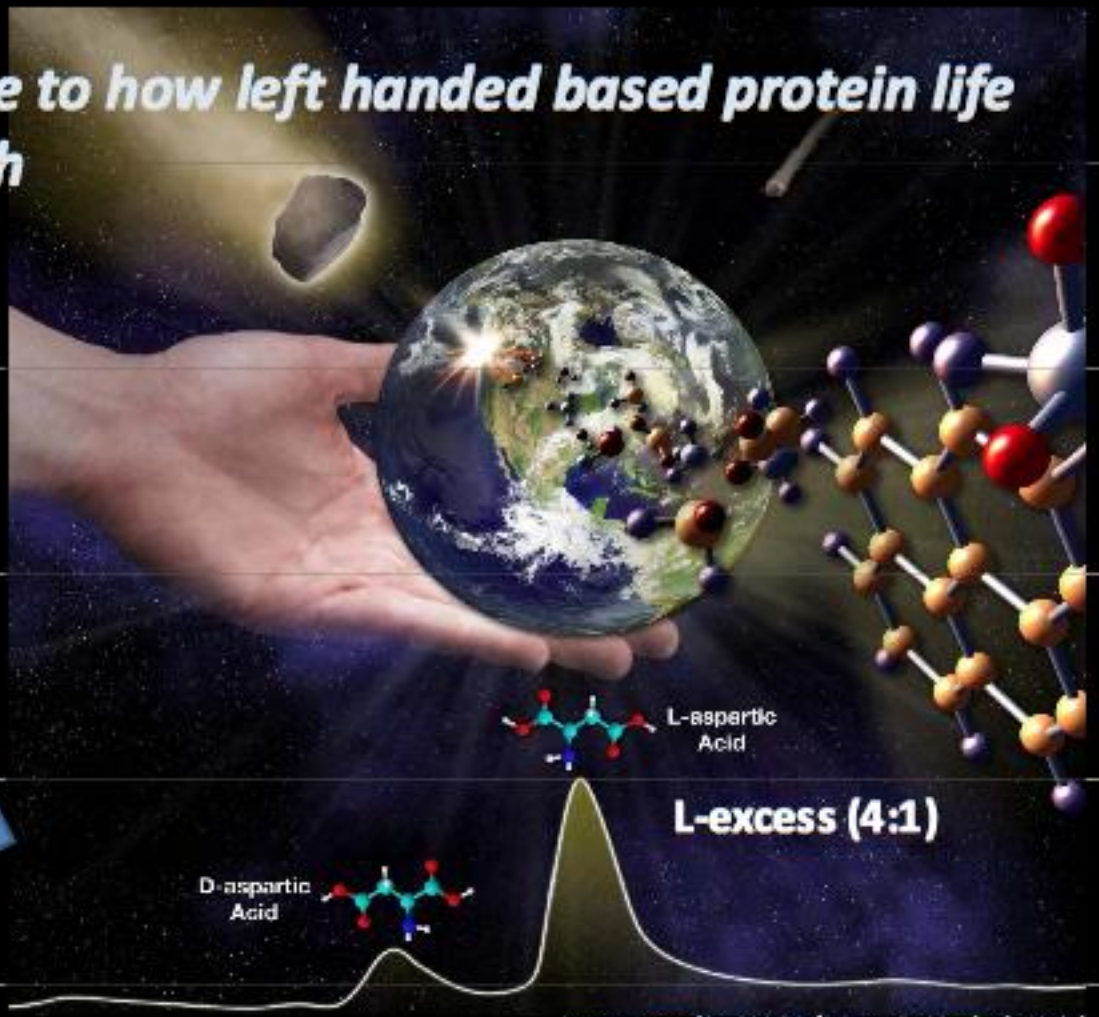


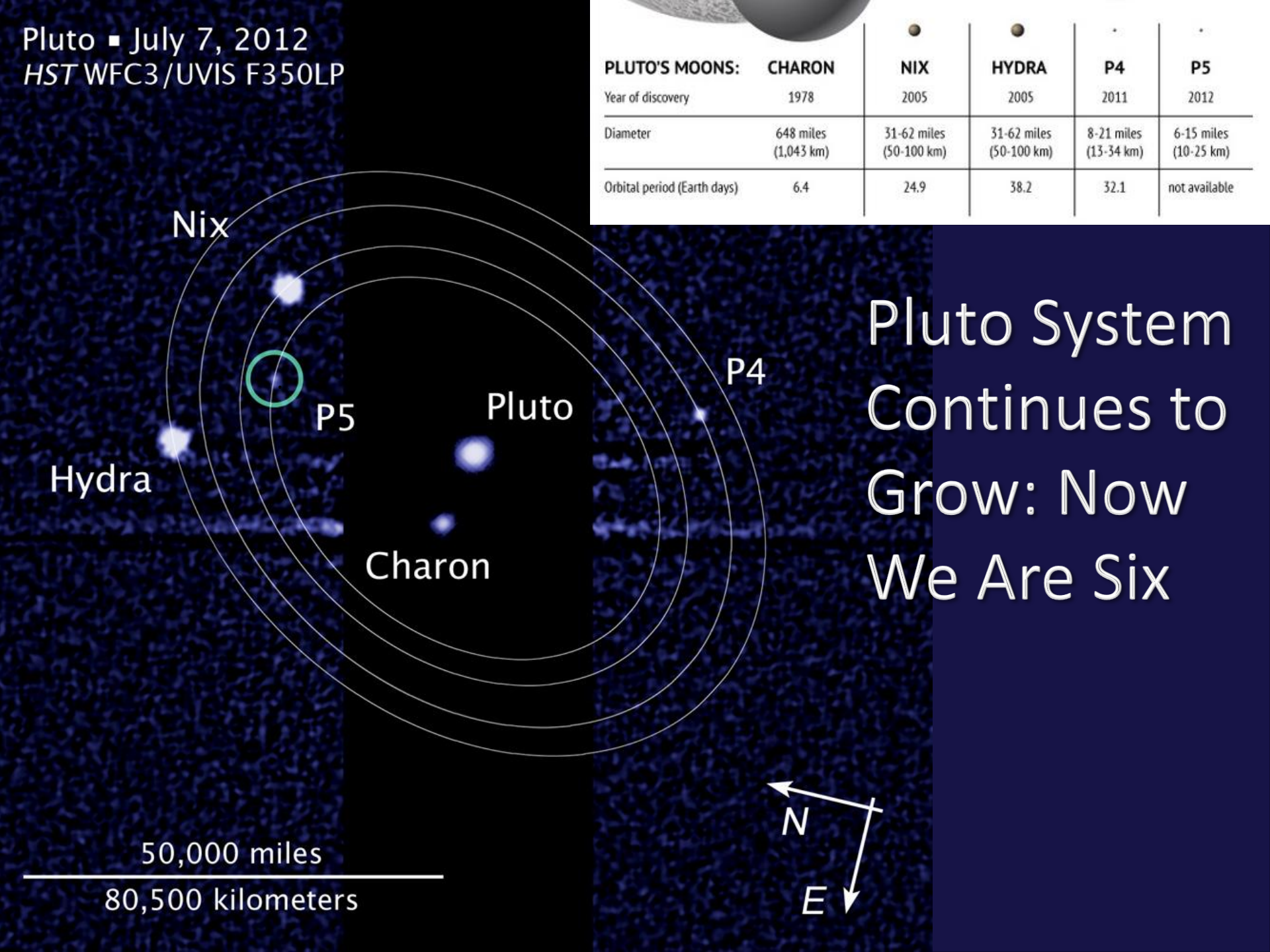
Image credit: NASA/Mary P. Hrybyk-Keith

Published in Meteoritics and Planetary Science:

D. Glavin, J. Elsila, A. Burton, M. Callahan, and J. Dworkin (NASA Goddard Space Flight Center)
R. Hilts (Grant MacEwan University)
C. Herd (University of Alberta)

Research supported by the NASA Astrobiology Institute and NASA Postdoctoral and Cosmochemistry Programs, and the Natural Sciences and Engineering Research Council of Canada

Link to NASA Press Release on July 25:
http://www.nasa.gov/topics/solarsystem/features/life-turned-left.html

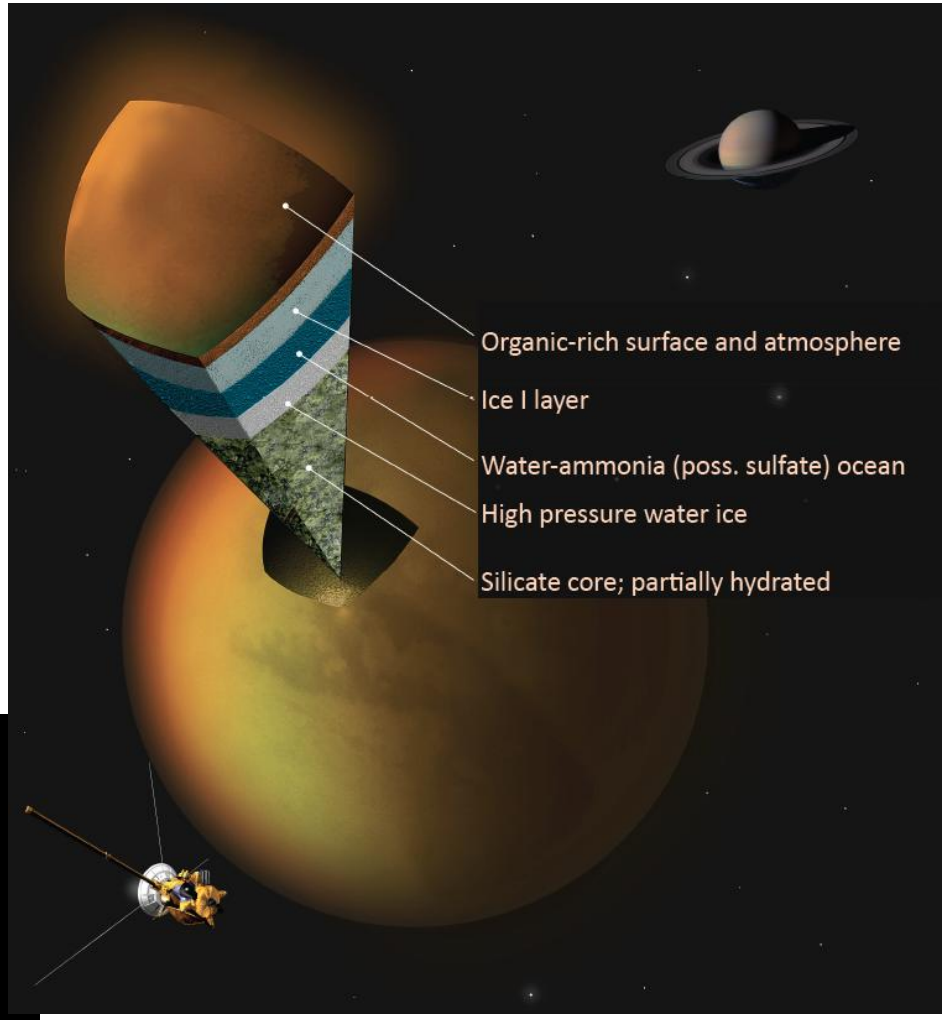


PLUTO'S MOONS:	CHARON	NIX	HYDRA	P4	P5
Year of discovery	1978	2005	2005	2011	2012
Diameter	648 miles (1,043 km)	31-62 miles (50-100 km)	31-62 miles (50-100 km)	8-21 miles (13-34 km)	6-15 miles (10-25 km)
Orbital period (Earth days)	6.4	24.9	38.2	32.1	not available

Pluto System Continues to Grow: Now We Are Six

Subsurface Ocean on Titan

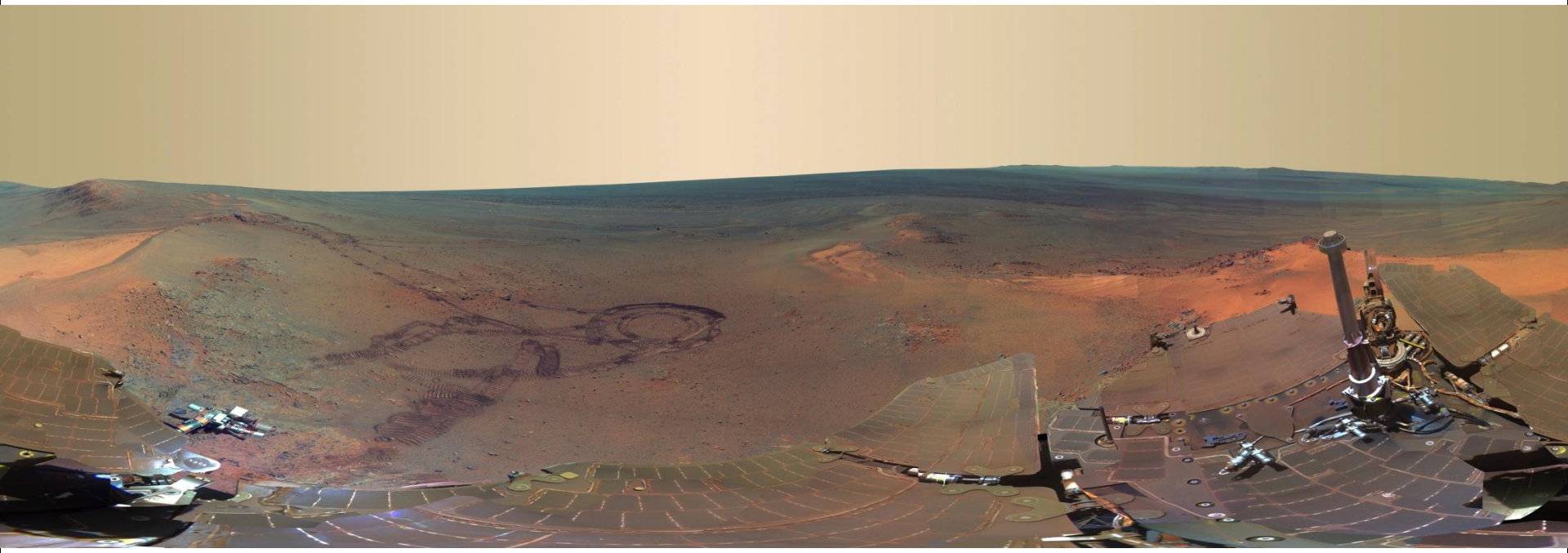
- Six close gravity flybys analyzed to study Titan's interior
- Large "solid" tides (10 m high) detected in Cassini gravity and are indicative of a liquid water ocean under Titan's ice shell
- Ocean may serve as reservoir to replenish Titan's atmospheric methane, which is destroyed on geologically short time scales



Model of Titan's interior

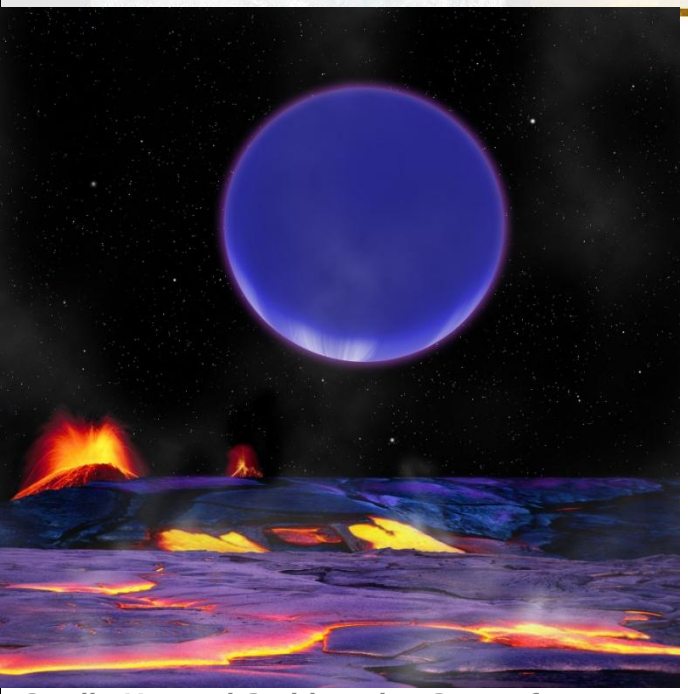
Less *et al.*, Science, June 28, 2012

Opportunity Concludes Winter Campaign



This ‘Greeley Panorama’ is a full-circle scene that combines 817 images taken by the panoramic camera (Pancam) on NASA's Mars Exploration Rover Opportunity. It shows the terrain that surrounded the rover while it was stationary for four months of work during its most recent Martian winter. The interior of Endeavour Crater can be seen just below the horizon in the right half of the scene, to the northeast and east of Cape York. The crater spans 14 miles (22 kilometers) in diameter.

Kepler Discovers Planetary Odd Couple

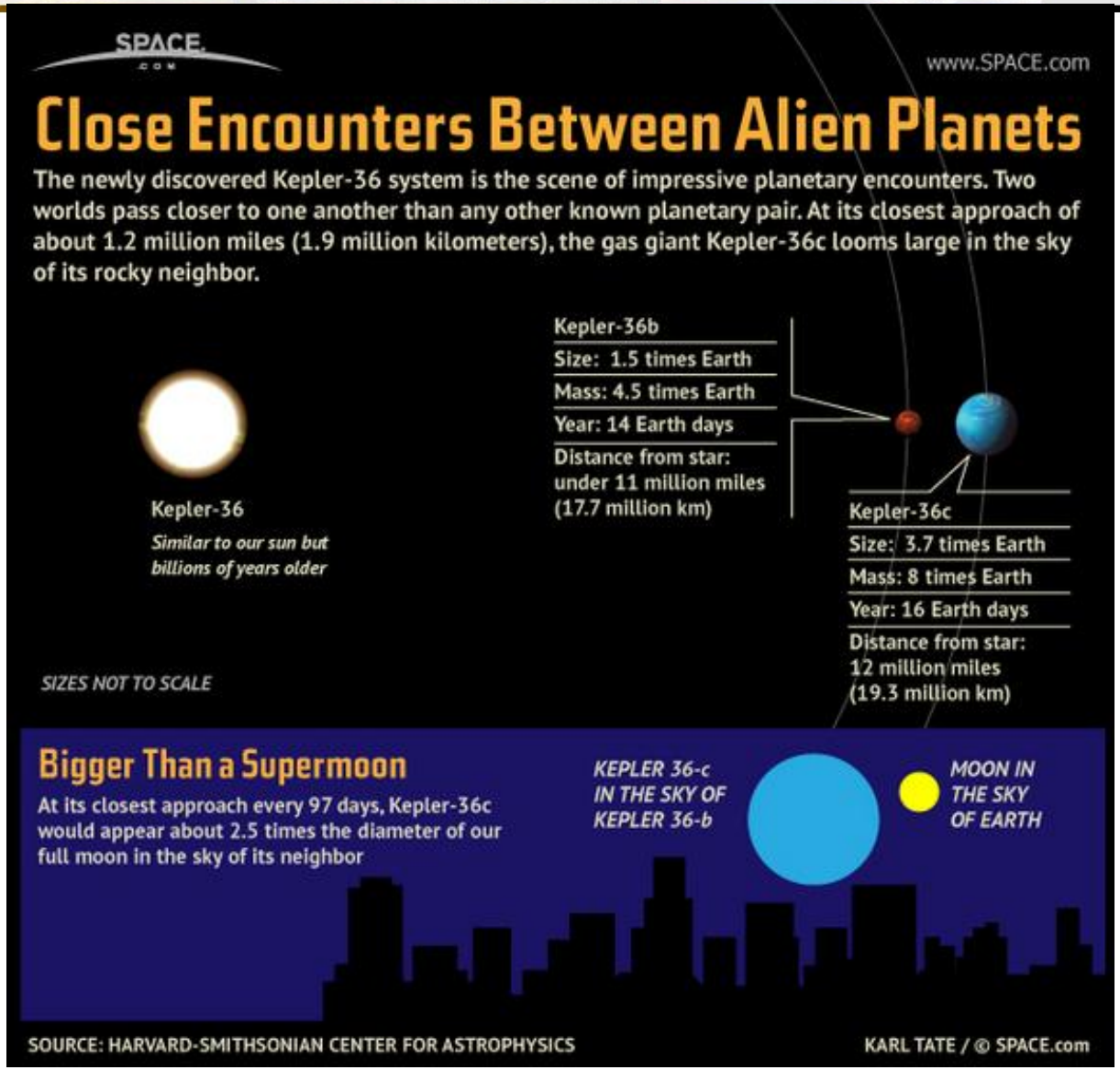


Credit: Harvard-Smithsonian Center for Astrophysics/David Aguilar.

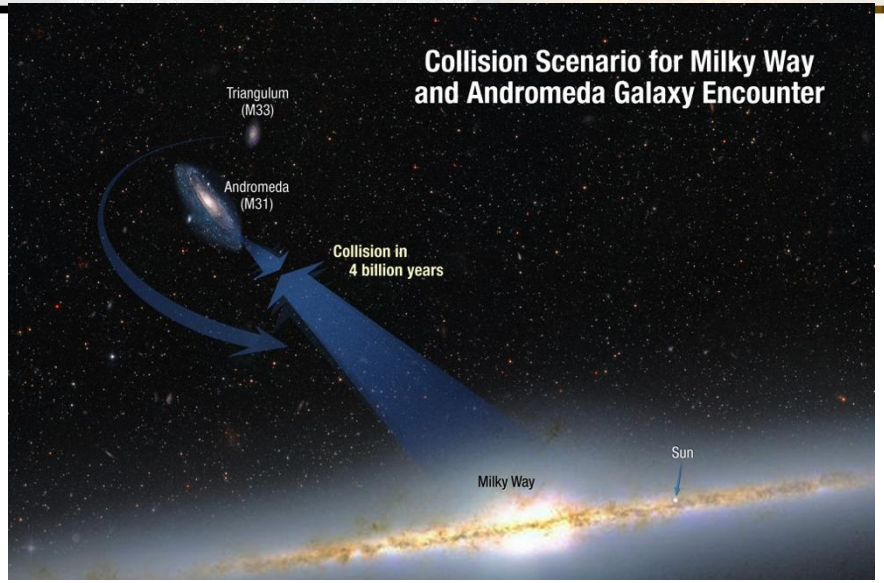
Planetrise: An artist's conception shows Kepler-36c as it might look from the surface of neighboring Kepler-36b.

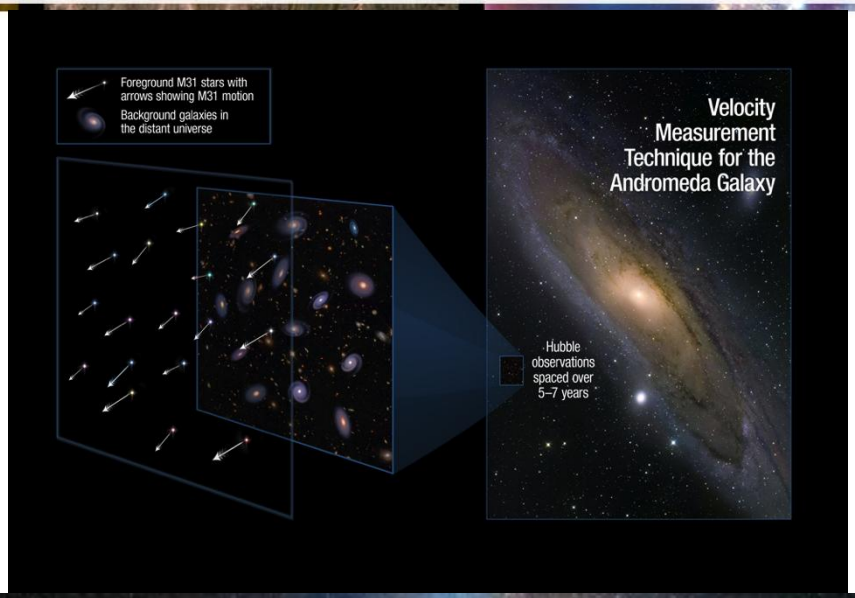
Kepler 36, G subgiant (G1IV), 1200 ly in Cygnus
Kepler-36b, hot super Earth, rocky planet with iron core
Kepler-36c, hot mini-Neptune with rocky core and low density

At closest approach every 97 days, separation less than 5 x Earth-Moon distance, significant tidal forces



Hubble Shows Milky Way is Destined for Head-on Collision with Andromeda Galaxy

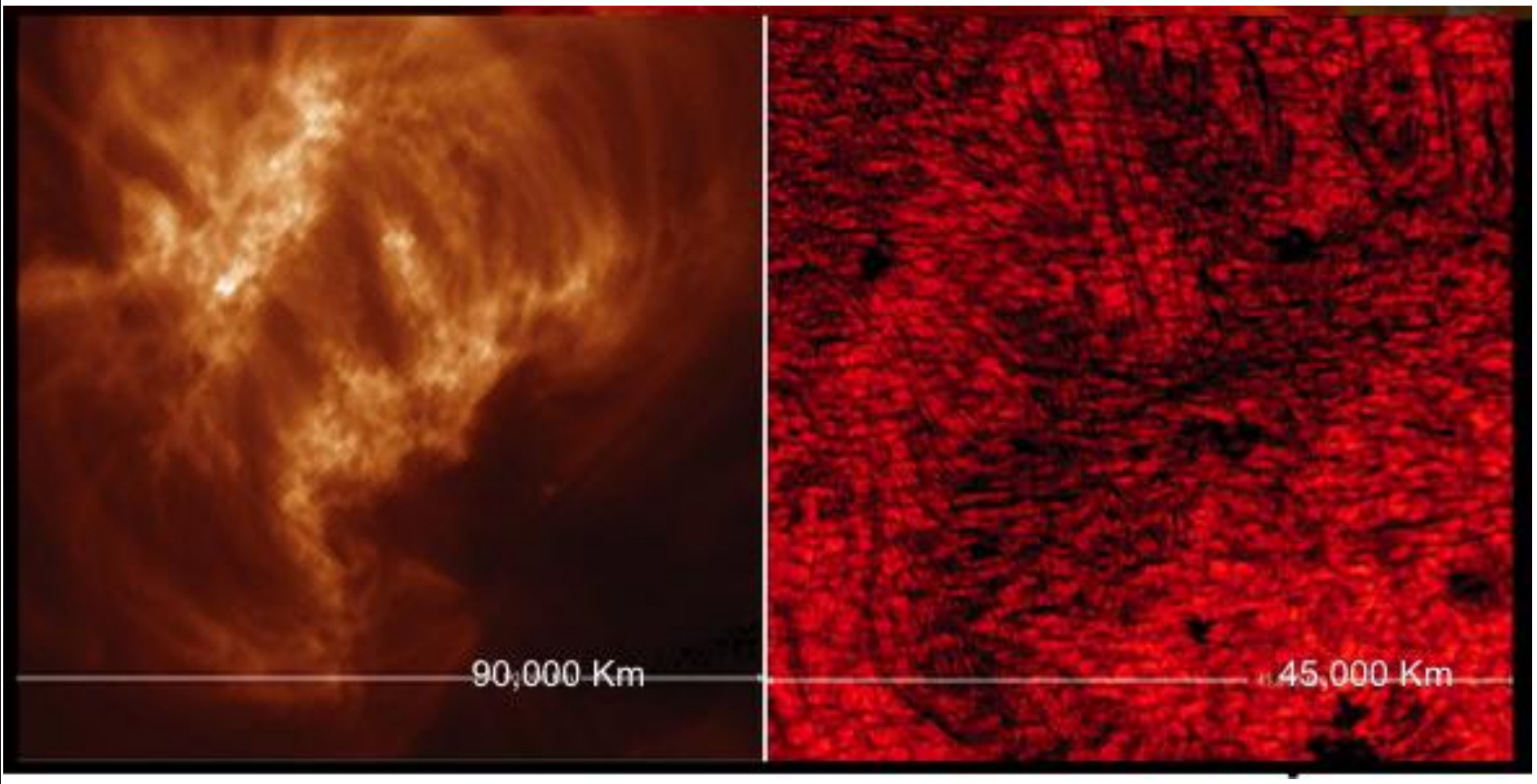




- Using images of M31 taken with ACS and WFC3 over a period of 5-7 years, HST has measured tangential motion of M31 to be very small (~.04 milli-arcseconds/year).
- Measuring the tangential motion of an object at 2.5 million light years is a significant accomplishment.
- Extrapolating the now completely known motion of M31 (and M33), the future of the Andromeda galaxy – Milky Way system can be simulated: the two galaxies will collide and merge in 4 billion years.

Artist concept, Science credit: NASA, ESA, Z. Levay and R. van der Marel (STScI), T. Hallas, and A. Mellinger

Ultrafine Loops in the Sun's Corona

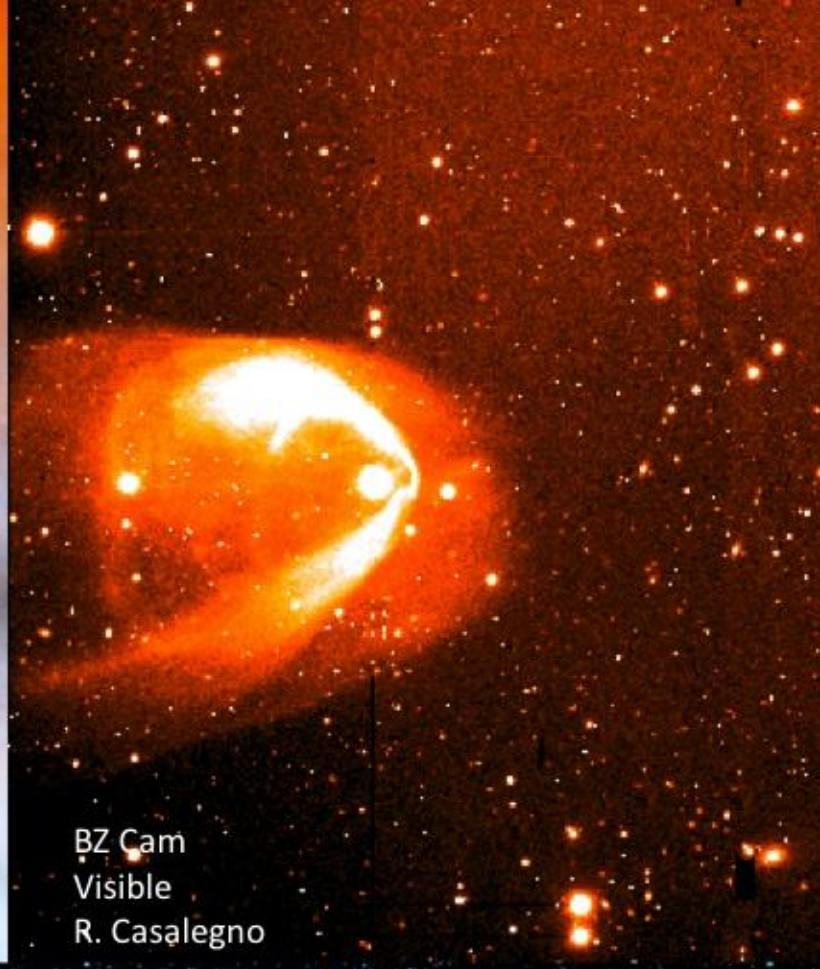


Wide loops of hot plasma extend high into the solar corona as seen by Solar Dynamics Observatory

New Solar Telescope observations of underlying connected loops 10x cooler and 10x narrower

ASTROSPHERES

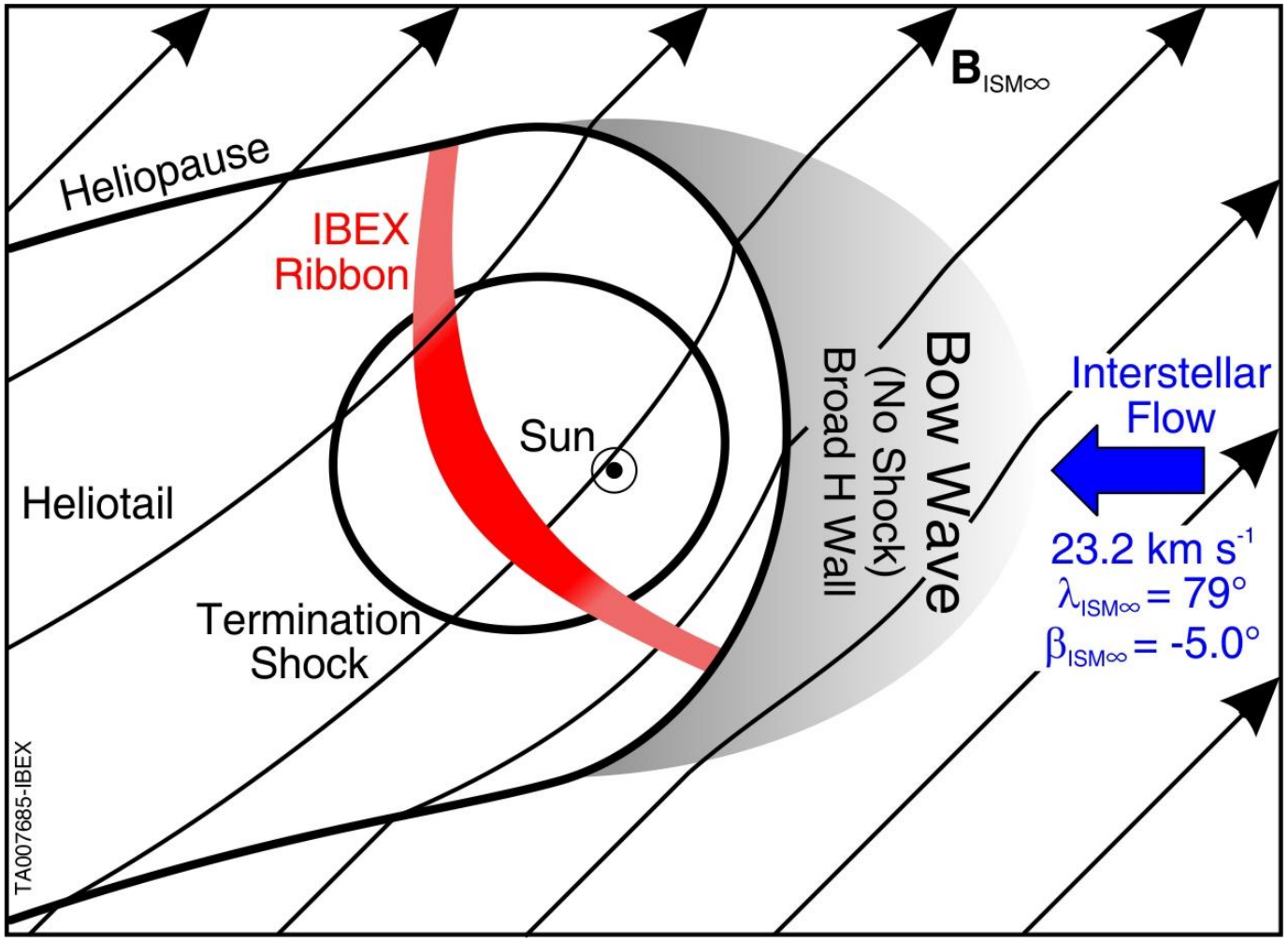
LL Orionis
Visible
Hubble



BZ Cam
Visible
R. Casalegno

Mira
Ultraviolet
GALEX

IBEX Discovers: No Heliospheric Bow Shock



Interstellar Boundary Explorer (IBEX) measurements reveal that the heliosphere moves through interstellar space more slowly than previously thought – too slow to produce a bow shock

McComas *et al.*, Science, 2012

Agenda

- Science Results
- **Programmatic Status**
- Findings & Recommendations

Mars Science Laboratory

Curiosity – Landing Soon!

9 Days Until Landing
August 6, 2012 EDT

http://www.nasa.gov/mars

Mars Program Planning Group (MPPG) Vision

T O D A Y

HUMAN EXPLORATION (HEOMD)

SCIENCE (SMD)

TECHNOLOGY (OCT / Space Technology)

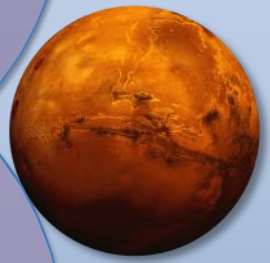
SAMPLE RETURN is a natural, initial Focal Point

*MPPG is creating the stage today for this to happen. It is a **starting point** to the future*

F U T U R E

HUMAN EXPLORATION

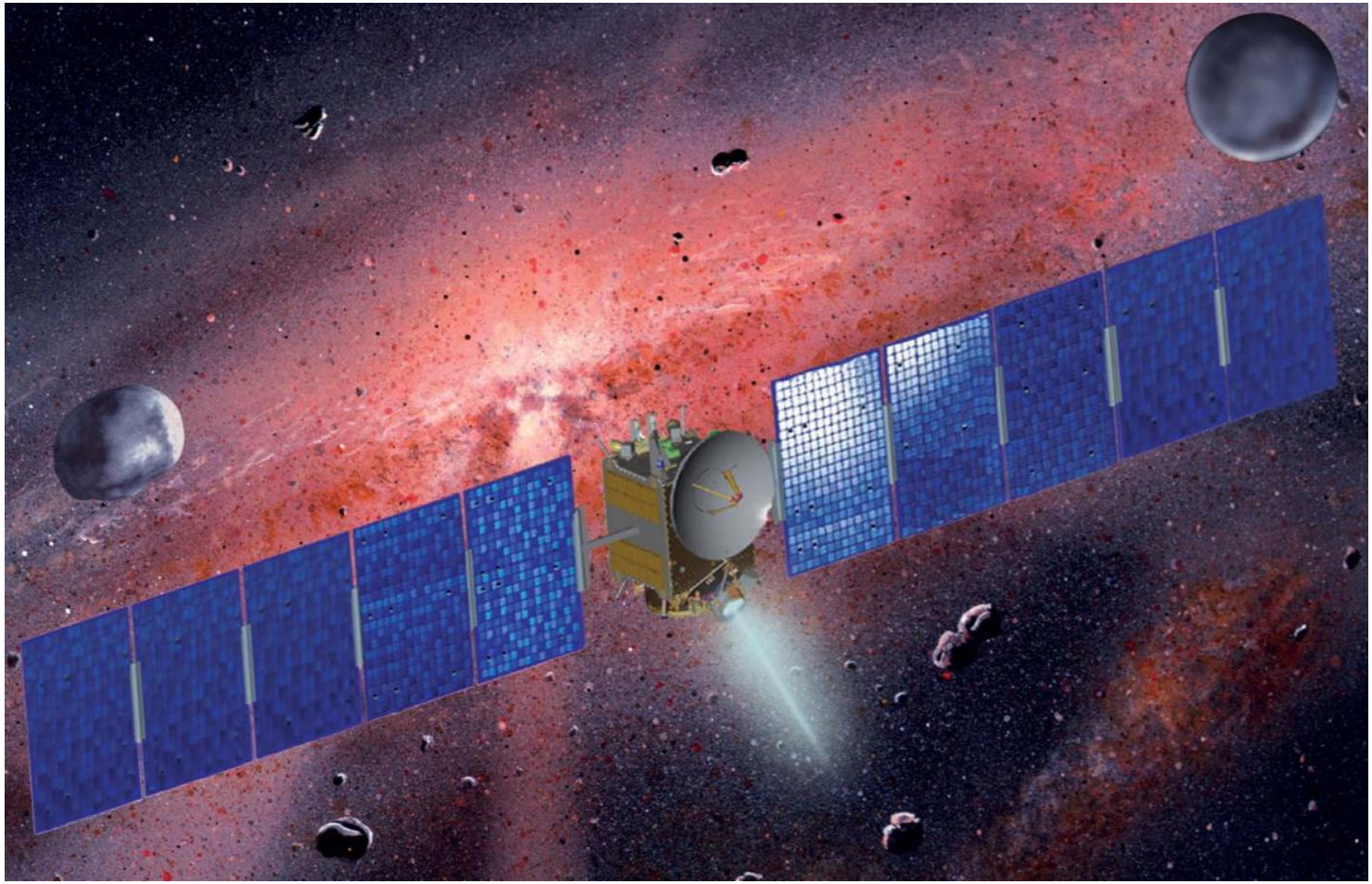
SCIENCE



MARS as the Destination

TECHNOLOGY

Dawn from Vesta to Ceres



- Was in high altitude orbit (~680 km) until July 25, at which point Dawn began to spiral out, and will leave for Ceres on August 23rd

Upcoming Launches

- MAVEN and LADEE in final phases of development for 2013 launch dates

B612 Foundation
Space Act Agreement

- The B612 Foundation “dedicated to preventing future asteroid impacts”
  - Nonprofit 501(c)3 organization
- B612 letter requested official discussions on a Space Act Agreement (SAA) for a space-based mission to survey near Earth asteroids of impact threat to Earth
  - Technical engineering advice
  - DSN Tracking and telemetry
  - Coordination/interface with existing NEO data network (MPC, JPL, etc.)
  - Cooperation with a science team
- B612 now in preliminary fund raising and working w/contractor on s/c design & mission plan
  - Design uses IR detector with spacecraft on interior “Venus-like” orbit
  - Development would begin early 2013
  - Tentative launch date is mid-2017
- SAA signed by SMD, HEOMD and B612 June 19, 2012

NRC's Earth Decadal Survey Mid-Term Report

- **Finding**: NASA responded favorably and aggressively to the decadal survey, embracing its overall recommendations for Earth observations, missions, technology investments, and priorities for the underlying science. As a consequence, the scientific and applications communities have made significant progress over the past 5 years.
- **Finding:** The **Earth Venture class program** is being well implemented by NASA and is a crucial component of fulfilling the decadal survey's objectives.
- **Finding: Alternative platforms and flight formations** offer programmatic flexibility. In some cases, they may be employed to lower the cost of meeting science objectives and/or maturing remote sensing and *in situ* observing technologies.
- **Finding:** NASA has made considerable efforts to secure **international partnerships** to meet its scientific goals and operational requirements.
- **Finding:** Aligned with the intent of the decadal survey, NASA's **Applied Sciences Program** has begun to engage applied researchers and governmental (federal and state) operational users on some survey mission science definition and applications teams and conduct research to better understand the value of these applications.

ESD Orbital Flight Portfolio – 2012-2020

– **LDCM**	11 Feb 2013	Atlas-5	(USGS)
– **GPM**	14 Feb 2014	H-IIA	(JAXA)
– **OCO-2**	1 July 2014	Delta-2	
– **SAGE-III/ISS**	Aug 2014	Falcon-9	(HEOMD,ESA,ISS)
– **SMAP**	31 Oct 2014	Delta-2	(CSA)
– **ICESat-2**	mid-2016	??	
– **CYGNSS**	mid-2016	*Pegasus*	(Venture-class)
– **GRACE-FO**	Aug 2017	*Partner*	(GFZ, DLR)
– ***OCO-3/ISS***	*Fall, 2017*	*Falcon-9 ?*	*(HEOMD, ISS)*
– **EV-Instrument/1**	NLT 2018	---	(Venture-Class)
– ***PACE***	*2019/2020*	*??*	
– **SWOT**	2020	??	(CNES)
– ***EV-Instrument/2***	*NLT 2020*	---	*(Venture-Class)*

– "Flight-like" Airborne Missions: **ICEBRIDGE** (2009-2017)

Senate Proposal: NOAA-NASA Funding Transfer

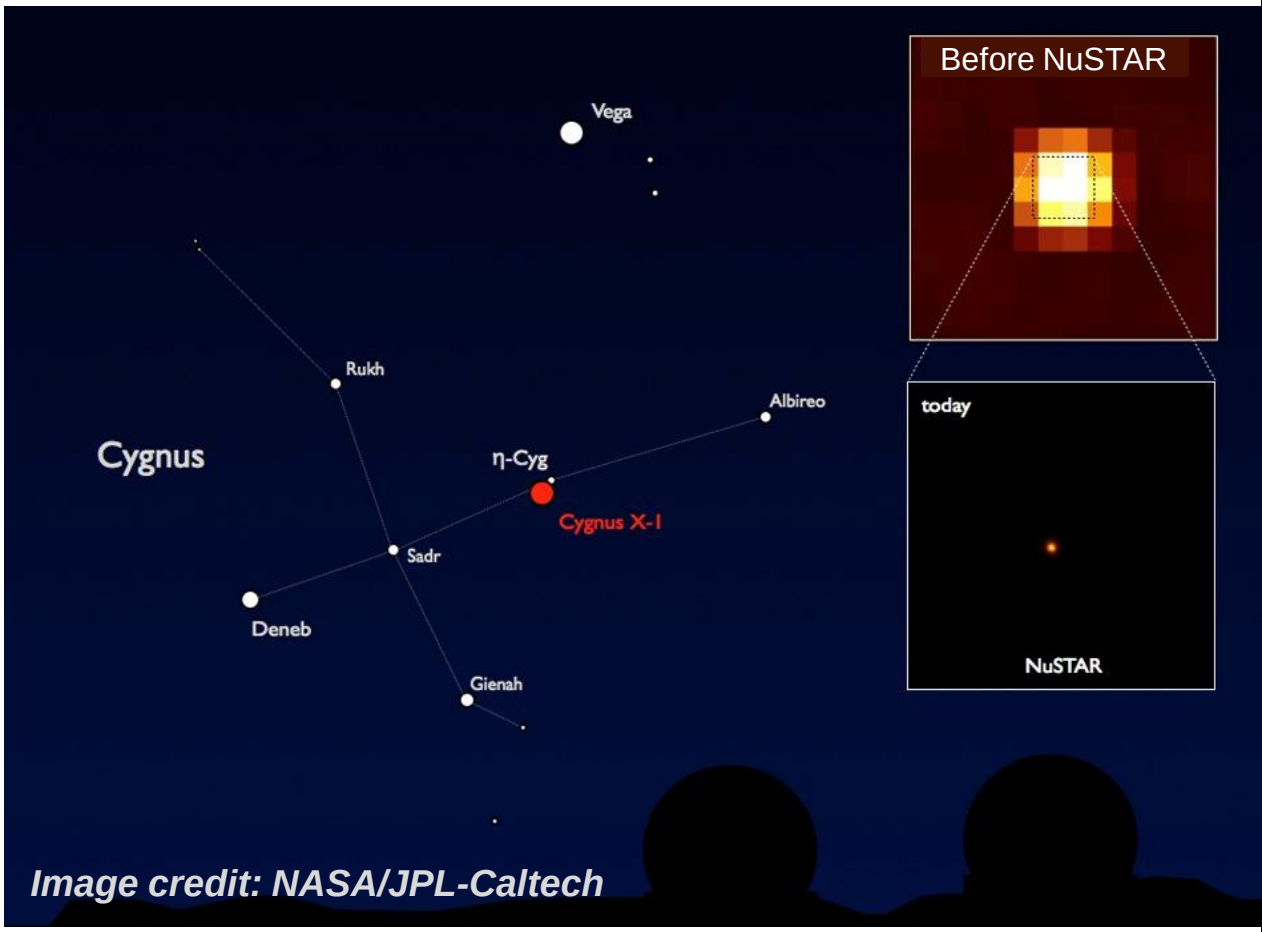
- **The Senate Appropriations Committee proposed that funding responsibility for development and launch of NOAA's Earth observing satellite missions be transferred from NOAA to NASA**
  - GOES-R, JPSS, Jason-3, DSCOVR are the present missions in development
  - Budget (~$1.6B in FY13) as well as responsibility to be transferred to NASA
  - Not yet voted on by the full Senate, House has passed their own version of the FY13 NASA/NOAA budgets, without the transfer of funding/responsibility
  - "Conference Committee" compromise will be necessary if the House and Senate bills differ

- **Basic work and interagency collaborations will not be changed**
  - NASA is presently, and will continue to be, the development and launch agency for the NOAA "operational" missions
  - NOAA will continue to operate the on-orbit operational meteorological and related missions
  - NOAA mission capability requirements will be taken into account

- ***NASA and NOAA continue to work as an interagency team to advance the development of these missions***

NuSTAR Launched - June 13, 2012

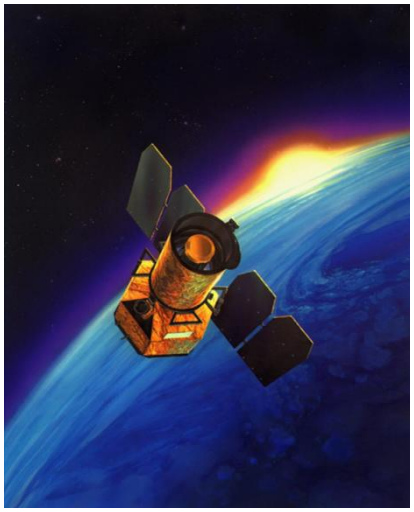
- Successfully launched June 13, 2012. On-orbit spacecraft operations are nominal
- 10m mast deployed on June 21, 2012
- Science “first light” of Cygnus X-1 taken June 28, 2012
- Ongoing science calibration involving multiple celestial objects e.g., Vela X-1, 3C273
- 2 year baseline science mission beginning Aug 1, 2012

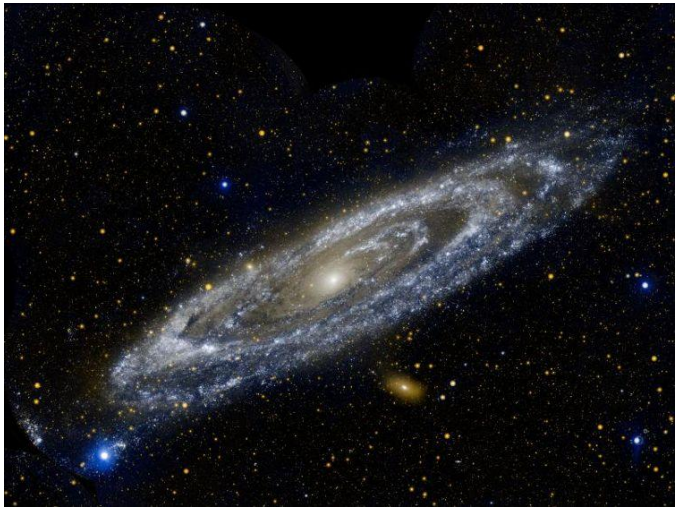


NuSTAR First Light of Cygnus X-1 (comparison to INTEGRAL image)

Galaxy Evolution Explorer (GALEX)

- Caltech is operating GALEX with private funds and may continue the science mission for as long as three years (extendable).
  - Caltech currently has funds for 5 months of operations from Keck Institute, Weizmann Institute, Cornell University, International consortium (GAMA/Herschel-Atlas/DINGO).
  - No change in data access for the community collected during the Caltech mission: all data will continue to be made publicly available after a 12 month period of exclusivity.
- A Space Act Agreement was signed on May 15, 2012 between NASA and Caltech which loans the spacecraft to Caltech.
- NASA holds long term liability and is responsible for decommissioning and re-entry.





Gravity and Extreme Magnetism Small Explorer (GEMS)

- The NASA Science Mission Directorate Program Management Council met on May 10, 2012 and evaluated the GEMS Key Decision Point C (Confirmation Review).
- Based on this review and the project's readiness documents, the Decision Authority for the GEMS project has non-confirmed the GEMS project to enter implementation, thereby terminating the mission.
- The primary rationale for non-confirmation is as follows:
  - Unacceptable cost, schedule, and technical risk of an AO-selected, cost capped mission.
    - GEMS turned out to be a greater technical challenge than originally anticipated
  - Significant descopes were taken during formulation to improve mass, power, cost, and schedule margins
    - Remaining descopes yield relatively small savings and/or have risk impact.
- NASA is conducting an independent review of SMD's decision to non-confirm GEMS. Report will be provided to Congress.
- Under Public Law 112-55, NASA is required to provide Congress with 15 days notification before a project is terminated and the funds are reallocated.
- Until the report is provided to Congress and the notification process is completed, the GEMS project continues.
- Funding planned for GEMS will go back to the Future Explorer budget to enable robust selections from the Explorer 2011 AO and to enable acceleration of future Explorer AOs.

Agenda

- Science Results
- Programmatic Status
- **Findings & Recommendations**

Recommendation

Short Title: New Telescope Assets

Recommendation: NASA should study possible scientific uses of the NRO-donated telescope assets, to see whether it can capitalize on this opportunity or not, exploring possible applications to high priority science identified in the various Decadal surveys in consultation with the broad scientific community.

Major Reasons for the Recommendation:
The donation appears to involve very high quality telescope assets with excellent capabilities, better than the best NASA UV/optical/near-infrared telescopes operating in space today (e.g., the Hubble Space Telescope).

The telescope assets could leverage the limited budget available for NASA science in the coming decade, for a much greater scientific reach than would otherwise be possible.

Recommendation (Cont'd)

Consequences of No Action on the Recommendation:
In order to decide how best to respond to the transfer of telescope of assets, NASA needs to understand – much better than it currently does – the possible scientific uses of these assets, considering possibilities across the Science Mission Directorate disciplines. Without more study, NASA's decision will be made in the absence of this crucial information.

Recommendation

Short Title: Planetary Protection Procedural Requirements Document for Human Extraterrestrial Missions

Recommendation:
The NAC recommends that NASA develop the appropriate implementing document to specify planetary protection procedural requirements for human extraterrestrial missions at a level corresponding to the current COSPAR (Committee on Space Research) planetary protection policy and adopt it as soon as practicable

Major Reasons for the Recommendation:
NASA Policy Document 8020.7G on “Biological Contamination Control for Outbound and Inbound Planetary Spacecraft” requires the development of detailed documents delineating the standards and procedures implementing compliance with planetary protection standards and procedures for human spaceflight missions. Currently, however, no such NASA documents exist for human missions.

Recommendation (Cont'd)

Consequences of No Action on the Recommendation:
NASA will be out of compliance with its own policy requirements as it plans the prominent flagship missions of human exploration and with international agreements to which the U.S. is a party.

Recommendation

Short Title: Independent Assessment of Cross-Directorate Mars Exploration

Recommendation:
The NAC Science Committee recommends that NASA arrange for independent, authoritative assessment and advice through the NRC about the newly established cross-Directorate partnership for the exploration of Mars.

Major Reasons for the Recommendation:
NASA needs the broad support of the U.S. space enterprise to realize the promise of success for Mars exploration during the next several decades. An independent assessment body will provide strategic guidance to Mars program plans, ensuring that goals are well connected to the priorities and strategies laid out in the Decadal Reports.

Consequences of No Action on the Recommendation:
NASA will be less able to integrate the goals of different stakeholder communities and garner the broad support of the space community for the Mars exploration program.

Recommendation

Short Title: Embracing the President's Export Control Reform

Recommendation:
The NAC recommends that NASA even more fully embrace and support the ongoing President's Export Control Reform (ECR) effort. To ensure that open scientific and international collaboration is enabled to the maximum extent possible, the NAC further recommends that NASA convene a discussion with the academic and non-profit community on the effects of current export control restrictions on international research and research projects that include foreign nationals.

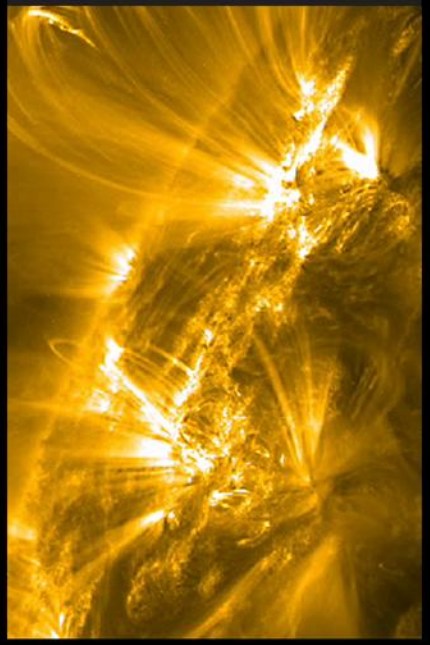
Recommendation (Cont'd)

Major Reasons for the Recommendation:
In carrying out its role as the preeminent space agency in the world, NASA engages in foreign collaborations in many of its programs, projects, and missions. Mutual exchange of knowledge and know-how in civil space technologies are an important part of these cooperative efforts. Additionally, NASA science is carried out at Universities, field centers, non-profits, and other organizations where foreign students and researchers are engaged in order to make these organization and NASA the best they can be. These critical interactions have been adversely effected and in some cases completely inhibited by the current export control regime.

Consequences of No Action on the Recommendation:
NASA will spend more money, have less robust programs, and miss important leadership opportunities.

National Aeronautics and Space Administration

EARTH SCIENCE



HELIOPHYSICS

PLANETARY SCIENCE

ASTROPHYSICS

Questions?

www.nasa.gov

Mission Decoder by Division

Earth Science mIssions

ACRIMsat	Active Cavity Radiometer Irradiance Monitor satellite
Aqua	Earth Observing Satellite mission for atmospheric dynamics
Aquarius	Ocean surface salinity mission with Argentina
Aura	Earth Observing Satellite for atmospheric chemistry
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
GPM	Global Precipitation Measurement
GRACE	Gravity Recovery and Climate Experiment
GRACE- FO	Gravity Recovery and Climate Experiment – Follow On
ICEsat-II	Ice, Clouds and land Elevation Satellite-II
Jason-1	Ocean surface topography satellite with France
Landsat	Land imaging satellite
LDCM	Landsat Data Continuity Mission
OCO-2	Orbiting Carbon Observatory-2
OSTM/Jason-2	Ocean Surface Topography Mission with France
QuikSCAT	Quick Scatterometer for ocean winds measurement
SAGE III	Stratospheric Aerosols and Gas Experiment III
SORCE	Solar Radiation and Climate Experiment
SMAP	Soil Moisture Active/Passive
Suomi NPP	Suomi National Polar-orbiting Partnership
Terra	Earth Observing System mission for land, ocean, and clouds
TRMM	Tropical Rainfall Measuring Mission

Heliophysics mIssions

ACE	Advanced Composition Explorer
AIM	Aeronomy of Ice in the Mesosphere
CINDI	Coupled Ion-Neutral Dynamics Investigation
Cluster-2	ESA-led four satellite mission to study Earth's magnetosphere
GEOTAIL	Japan/NASA mission to study Earth's magnetotail
Helio EX-1	To be selected Helio Explorer mission
IBEX	Interstellar Boundary Explorer
IRIS	Interface Region Imaging Spectrograph
LWS SET-1	Living With a Star Space Environment Testbed - 1
MMS	Magnetospheric Multiscale
RHESSI	Reuven Ramaty High Energy Solar Spectroscope Imager
RBSP	Radiation Belt Storm Probes
SDO	Solar Dynamics Observatory
SOHO	Solar and Heliospheric Observatory
STEREO	Solar Terrestrial Relations Observatory
THEMIS	Time History of Events and Macroscale Interactions during Substorms
TIMED	Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics
TWINS A&B	Two Wide-Angle Imaging Neutral-Atom Spectrometers
Voyager	Missions to the outer planets, now at the heliopause

Astrophysics mIssions

Astro EX-1	To be selected Astro Explorer mission
Astro-H	Japan facility class X-ray mission
Fermi	Fermi Gamma-ray Large Area Space Telescope
GALEX	Galaxy Evolution Explorer
GEMS	Gravity and Extreme Magnetism Small Explorer
Herschel	ESA infrared space telescope
HST	Hubble Space Telescope
Integral	International Gamma-Ray Astrophysics Laboratory
JWST	James Webb Space Telescope
Kepler	Discovery mission to detect extrasolar planets
NuSTAR	Nuclear Spectroscopic Telescope Array
Planck	ESA microwave space telescope
SOFIA	Stratospheric Observatory For Infrared Astronomy
Spitzer	Spitzer infrared space telescope
Suzaku	Japan X-ray telescope
Swift	Gamma ray burst space telescope
WISE	Wide-field Infrared Survey Explorer
WMAP	Wilkinson Microwave Anisotropy Probe
XMM-Newton	ESA mission to observe celestial X-ray sources

Planetary Science mIssions

ARTEMIS –	Acceleration, Reconnection, Turbulence, and Electrodyanamics of the Moon's Interaction with the Sun
Cassini	Flagship mission to Saturn and its moons
Dawn	Discovery mission to visit the asteroids Vesta and Ceres
Deep Impact	Discovery mission to impact comet Tempe I-1
EPOXI	Extrasolar Planet Observation and Deep Impact Extended Investigation
GRAIL	Gravity Recovery and Interior Laboratory
Juno	New Frontiers mission to Jupiter
LADEE	Lunar Atmosphere and Dust Environment Explorer
LRO	Lunar Reconnaissance Orbiter
MAVEN	Mars Atmosphere and Volatile Evolution
MER	Mars Exploration Rovers (Spirit & Opportunity)
MESSENGER	Mercury Surface, Space Environment, Geochemistry and Ranging
MRO	Mars Reconnaissance Orbiter
MSL	Mars Science Laboratory
MSR	Mars Sample Return
New Horizons	New Frontiers mission to fly by Pluto and into the Kuiper Belt
OSIRIS-REx	Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer
Rosetta	ESA mission to return a sample from a comet
Strofio	Mass spectrometer instrument for ESA's Bepi/Colombo mission

NOAA Reimbursable missions

DSCOVR	Deep Space Climate Observatory
GOES-R series	Geostationary Operational Environmental Satellites
Jason-3	Ocean surface topography satellite
JPSS 1&2	Joint Polar-orbiting Satellite System